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Impact of Cavity Shaving on Margin Status and Re-excision Rates in Breast-Conserving Surgery: Experience from a Single Institute

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ABSTRACT

Background: The comparative outcomes of breast-conserving surgery (BCS) with and without cavity shave margins (CSM) are not well established, despite prior randomized and observational studies, due to heterogeneity in patient populations and margin definitions. We aim to evaluate the impact of each procedure on final margin status and subsequent re-excision rates.

Methods: We conducted a retrospective study comprising 529 women who underwent either BCS with CSM or BCS without CSM between 2013 and 2015 for ductal carcinoma in situ (DCIS), invasive ductal carcinoma (IDC), or both at Detroit Medical Center, Michigan. Data, including final margin status (inked and close margin) and re-excision status, were collected. Statistical analysis was performed using univariable and multivariable logistic regression analyses.

Results: Our analysis revealed no significant reduction in the incidence of positive margins (involved and tumor within 2 mm) among patients who underwent either procedure. In the univariable analysis, patients without lymph node (LN) metastases, those who underwent BCS with CSM, and those with pure IDC had a decreased risk of re-excision compared with those without LN sampling and those with only DCIS (all $P < 0.001$), respectively. These factors also remained significant in multivariable analysis.

Conclusion: Although no significant difference was observed between the 2 procedures in reducing the incidence of positive margins among patients with only IDC, only DCIS, and both IDC and DCIS, CSM showed a lower need for re-excision, particularly in cases with pure IDC.

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INTRODUCTION

Breast cancer is the most common malignancy among women in the United States (US). According to the American Cancer Society, the incidence of invasive and noninvasive breast cancer in the US for 2025 was approximately 316 950 and 59 080,

respectively.[1] Treatment of breast cancer varies, ranging from lumpectomy to mastectomy, often combined with customized oncoplastic approaches and reconstructive procedures.[2]

Breast-conserving surgery (BCS) followed by whole-breast radiation, which aims to excise the tumor and obtain completely negative resection margins, has been widely adopted because it provides the same prognosis as mastectomy while maximally preserving the cosmetic appearance of the breast.[3] However, local cancer recurrence remains a key challenge for surgeons and oncologists, frequently necessitating additional surgery. One of the strongest predictors of local recurrence is the presence of positive surgical margins[4], which often necessitates a second surgery.[5–7] These subsequent surgeries for re-excision are associated with an added financial burden, increased potential for patient morbidity, greater patient anxiety, and worse cosmesis.[8, 9]

Cavity shave margin (CSM) is a technique that involves the resection of the additional margins from the tumor bed after primary tumor excision. The additional margins are then labeled, oriented, and inked at the pathology laboratory. The pathologist then assesses these margins as the new final margins and renders a final pathological diagnosis based on them.

The Society of Surgical Oncology (SSO) and the American Society for Radiation Oncology (ASTRO) have recommended the following definition of negative surgical margin: no tumor on the inked margin in case of invasive cancer[10] and no tumor at least 2 mm from the inked surface for ductal carcinoma in situ (DCIS).[11]

Several studies have demonstrated that CSM is a potentially effective method for reducing positive margins and re-excision rates without compromising aesthetic outcomes[7, 12, 13] Despite these findings, barriers to its routine adoption include the lack of consensus on the definition of an acceptable negative margin and the variation in cavity shaving volume between different surgeons[14–16], as well as a lack of standardized protocol among institutions and the preferences of the treating surgeons.

In this single-institution study, we aimed to compare the effect of performing the CSM procedure in conjunction with BCS on the final margin status and re-excision rates in patients with invasive ductal carcinoma (IDC) and/or DCIS with that of BCS without CSM. This topic warrants prompt attention, as it directly impacts patient outcomes and informs the selection of an appropriate treatment approach.

METHODS

We conducted a single-institution retrospective study comprising 529 women with a biopsy-proven diagnosis of IDC and/or DCIS who underwent either partial mastectomy with CSM or without CSM between January 1, 2013, and December 31, 2015, at Detroit Medical Center. Data analysis was performed in 2022. Exclusion criteria included (1) male sex; (2) age younger than 18 years; (3) tumor other than IDC and DCIS histology (such as lobular carcinoma in situ, invasive lobular carcinoma, neuroendocrine carcinoma, and other rare tumors); (4) presence of residual and/or recurrent disease; (5) history of prior surgical excision such as excisional biopsies or partial mastectomy; (6) prior neoadjuvant chemotherapy; and (7) patients who underwent oncoplastic techniques.

We classified cases as “with CSM” if the patient received cavity shave excision of all 6 margin faces (superior, inferior, lateral, medial, anterior, and posterior) and “without CSM” if the patient underwent primary excision without additional shave margins. Three surgeons participated in the study. In accordance with the surgeon’s practice, neither partial cavity shave procedures (shave excision of ≥ 1 but < 6 margin faces) nor intraoperative frozen section analysis was performed. Patients with a high risk for lymph node (LN) disease, including those with high-grade IDC, DCIS, or clinical and radiological indications of axillary disease, also underwent axillary LN dissection. We obtained postprocedure margin status as a pathological end point for both IDC and DCIS with reference to 2 definitions: (1) positive margin: tumor on the inked margin for IDC; and (2) positive close margin: tumor within 2 mm of the inked margin for both IDC and DCIS. At our institution, close margins were generally managed as follows: for cases with pure DCIS, a re-excision was performed when the DCIS was 2 mm or less from the inked margin. In contrast, for cases with both invasive and in situ components, positive close margins for DCIS and/or IDC did not prompt re-excision, provided the inked margins were negative for either component. For IDC, re-excision was performed only when IDC was present on the inked margin.

The decision to re-excise, representing the clinical decision-making outcome, was left to the discretion of the treating surgeon and was independent of patient or tumor characteristics.

We collected data regarding the patients’ age and tumor characteristics, including (1) DCIS status, grade, size, and margin status (tumor on the ink and within 2 mm of the inked margin); (2) IDC status, grade (based on established criteria for tubule formation, nuclear pleomorphism, and mitotic count according to the Nottingham Grading System[22]), size, focality (unifocal or multifocal), and margin status (tumor on the ink and within 2 mm of the inked margin); (3) type of LN excised: sentinel LN or

axillary LN; (4) size of metastases to LN: macrometastases (> 2 mm), micrometastases (> 0.2 to ≤ 2.0 mm), and isolated tumor cells (ITCs) (≤ 0.2 mm or 200 cells)[19]; and (5) type of surgical procedure performed: BCS with or without CSM.

We first stratified the data into 2 groups based on the surgical procedure performed (BCS with CSM or standard BCS). We further subdivided these groups into 3 categories based on invasive and/or in situ disease: patients with only DCIS, patients with only IDC, and patients with both IDC and DCIS.

Statistical analysis

Baseline patient characteristics were summarized using frequency (percentage) for categorical variables and median (IQR) [minimum-maximum] for continuous variables. A comparison of categorical variables was done using Fisher exact tests, and Wilcoxon rank sum tests were used for continuous variables. "Not applicable" values, reflecting inherent biological differences between the DCIS-only, IDC-only, and mixed cohorts, were treated as a separate category and included in percentage calculations and *P* value analyses to allow comprehensive group comparisons, whereas true "Missing" values were excluded from comparisons. Based on the literature, the following 4 covariates were selected for univariable and multivariable logistic regression analyses of 3 outcomes: re-excision, tumor on the inked margin, and tumor within 2 mm of the inked margin: patient age, LN status, surgical procedure group (with or without CSM), and pathological classification group (pure DCIS only, pure IDC only, or both present). The selection of these variables was based on clinical relevance and expert knowledge rather than a statistical selection process. Subgroup analyses comparing re-excision rates between surgical procedures among patients with positive or close margins were performed as exploratory analyses to provide clinical context.

RESULTS

Patient characteristics

Baseline patient characteristics, categorized by surgical procedure type, are summarized in Table 1. After applying our study's inclusion and exclusion criteria, a total of 529 patients were included in the study. Overall, 162 patients (30.6%) underwent BCS with CSM, whereas 367 patients (69.4%) underwent BCS without CSM. The groups were comparable at baseline in clinicopathological characteristics, with no significant differences in DCIS status, DCIS grade, IDC size, IDC grade, and IDC focality ($P > 0.05$ for all comparisons) except for age and DCIS size (Table 1). The overall median age was 59 years. The median age for patients in the CSM group was 62 years, compared with 58 years in the non-CSM group. Patients in the CSM group also had a significantly larger median DCIS size (2.8 cm vs 2.0 cm; $P = 0.03$). Among the patients who underwent LN sampling (n = 414), 150 patients had positive LN metastases. Patients in the CSM group with positive LN metastases had a higher rate of sentinel LN biopsy than those in the non-CSM group (60.5% vs 39.3%; $P = 0.03$). Missing values are summarized in Table 1.

Table 1. Patient Characteristics by Type of Surgical Procedure Variable

	All (N=529)	Without cavity shave margins (n=367)	With cavity shave margins (n=162)	*P* value[a]
Age, y, median (IQR) [Min, Max]	59 (16) [24, 90]	58 (16.5) [24, 90]	62 (15) [33, 89]	0.001
DCIS status, No. (%)				0.06
Negative	152 (28.7)	96 (26.2)	56 (34.6)	
Positive	377 (71.3)	271 (73.8)	106 (65.4)	
DCIS grade, No. (%)				0.19
Low	60 (11.3)	42 (11.4)	18 (11.1)	
Intermediate	149 (28.2)	103 (28.1)	46 (28.4)	
High	165 (31.2)	123 (33.5)	42 (25.9)	
Not applicable	152 (28.7)	96 (26.2)	56 (34.6)	
Missing	3 (0.6)	3 (0.8)	0 (0)	
IDC status, No. (%)				0.51
Negative	125 (23.6)	90 (24.5)	35 (21.6)	
Positive	404 (76.4)	277 (75.5)	127 (78.4)	
IDC grade, No. (%)				0.65
Low	64 (12.1)	44 (12)	20 (12.3)	
Intermediate	173 (32.7)	114 (31.1)	59 (36.4)	
High	160 (30.2)	114 (31.1)	46 (28.4)	
Not applicable	125 (23.6)	90 (24.5)	35 (21.6)	
Missing	7 (1.3)	5 (1.4)	2 (1.2)	
Tumor size, cm, median (IQR) [Min, Max]	1.9 (1.9) [0.2, 13.6]	1.9 (2.0) [0.2, 12.4]	1.8 (1.8) [0.2, 13.6]	0.87

Missing	10	9	1	
DCIS size, cm, median (IQR) [Min, Max]	2.4 (3) [0.4, 20.4]	2 (2.8) [0.4, 17.6]	2.8 (4) [0.4, 20.4]	0.03
Not applicable	144	90	54	
Missing	26	19	7	
IDC margin status, No. (%)				0.10
Negative	365 (69)	245 (66.8)	120 (74.1)	
Positive	40 (7.6)	33 (9)	7 (4.3)	
Not applicable	124 (23.4)	89 (24.3)	35 (21.6)	
DCIS margin status, No. (%)				0.14
Negative	335 (63.3)	242 (65.9)	93 (57.4)	
Positive	45 (8.5)	31 (8.4)	14 (8.6)	
Not applicable	149 (28.2)	94 (25.6)	55 (34)	
IDC 2 mm from margin, No. (%)				0.66
Negative	258 (48.8)	179 (48.8)	79 (48.8)	
Positive	145 (27.4)	97 (26.4)	48 (29.6)	
Not applicable	126 (23.8)	91 (24.8)	35 (21.6)	
DCIS 2 mm from margin, No. (%)				0.06
Negative	208 (39.3)	155 (42.2)	53 (32.7)	
Positive	170 (32.1)	117 (31.9)	53 (32.7)	
Not applicable	151 (28.5)	95 (25.9)	56 (34.6)	
IDC focality, No. (%)				0.66
Unifocal	243 (45.9)	171 (46.6)	72 (44.4)	
Multifocal	82 (15.5)	62 (16.9)	20 (12.3)	
Not applicable	131 (24.8)	92 (25.1)	39 (24.1)	
Missing	73 (13.8)	42 (11.4)	31 (19.1)	
LN status, No. (%)				0.79
Without LN sampling	114 (21.6)	77 (21)	37 (22.8)	
Negative	264 (49.9)	182 (49.6)	82 (50.6)	
Positive	150 (28.4)	107 (29.2)	43 (26.5)	
Type of LN[b]				0.03[b]
Sentinel biopsy	68 (45.3)	42 (39.3)	26 (60.5)	
Axillary LN	82 (54.7)	65 (60.7)	17 (39.5)	
Size of tumor metastasis to the LN[b]				0.12[b]
Micrometastasis	19 (12.7)	10 (9.3)	9 (20.9)	
Macrometastasis	117 (78)	85 (79.4)	32 (74.4)	
Isolated tumor cells	4 (2.7)	2 (1.9)	2 (4.7)	
Missing	10 (6.7)	10 (9.3)	0 (0)	
Missing	1 (0.2)	1 (0.3)	0 (0)	

DCIS, ductal carcinoma in situ; IDC, invasive ductal carcinoma; IQR, interquartile range; LN, lymph node; Max, maximum; Min, minimum.
[a] P value was calculated by Wilcoxon rank sum test for continuous variables and Fisher exact test for categorical variables.
[b] Patients with positive LN invasion only.
Percentages may not total 100% due to rounding.

Factors associated with the presence of tumor on the inked margin

In multivariable analysis (Table 2), patients without LN metastases who had pure IDC had a lower risk of tumor on the inked margin compared with patients who did not undergo LN sampling (OR, 2.51; 95% CI, 1.29–4.87; $P = 0.007$), those with LN metastases (OR, 1.94; 95% CI, 1.04–3.59; $P = 0.04$), and those with only DCIS (OR, 3.38; 95% CI, 1.37–8.38; $P = 0.008$) or with both invasive and in situ cancer (OR, 3.34; 95% CI, 1.57–7.09; $P = 0.002$), respectively. Inked margin positivity was observed in 20 of 162 patients in the CSM group (IDC = 3, DCIS = 7, both = 10) and in 61 of 367 patients in the non-CSM group (IDC = 6, DCIS = 30, both = 31). In patients with IDC and DCIS, both components were present on the inked margin. Neither technique demonstrated a significant reduction in the incidence of a positive inked margin ($P > 0.05$) in either univariable or multivariable analysis. However, this finding should be interpreted with caution, given the retrospective design, limited number of events, and potential for selection bias.

Table 2. Univariable and Multivariable Logistic Regression Analysis for Factors Associated with Tumor-Positive Margins

		Univariable		Multivariable	
	Event/n	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	81/529	1.01 (0.99–1.03)	0.59	1.01 (0.99–1.03)	0.52
LN status					
Negative	27/264	Ref		Ref	
Positive	25/150	1.76 (0.98–3.15)	0.06	1.94 (1.04–3.59)	0.04
Without LN sampling	29/114	2.99 (1.68–5.35)	<0.001	2.51 (1.29–4.87)	0.007
Type of operation					
Without cavity shave margins	61/367	Ref		Ref	
With cavity shave margins	20/162	0.71 (0.41–1.22)	0.21	0.73 (0.41–1.28)	0.27
Group					
IDC only	9/152	Ref		Ref	
DCIS only	27/125	4.38 (1.97–9.71)	<0.001	3.38 (1.37–8.38)	0.008
DCIS+IDC	45/252	3.45 (1.64–7.29)	0.001	3.34 (1.57–7.09)	0.002

CI, confidence interval; DCIS, ductal carcinoma in situ; Event/n, numbers of events (positive) and patients; IDC, invasive ductal carcinoma; LN, lymph node; OR, odds ratio.

Factors associated with the presence of tumor within 2 mm of the inked margin

In the multivariable analysis (Table 3), patients without LN metastases and those with only IDC had a lower risk of having a tumor within 2 mm of the inked margin compared with those without LN sampling (OR, 2.02; 95% CI, 1.21–3.38; $P = 0.007$) and those with only DCIS (OR, 1.91; 95% CI, 1.08–3.36; $P = 0.03$) or with both invasive and in situ cancer (OR, 2.19; 95% CI, 1.44–3.33; $P < 0.001$), respectively. Also, 82 of 162 patients in the CSM group and 179 of 367 patients in the non-CSM group had a final margin that was positive for a close margin. In patients with both IDC and DCIS, both components were present within 2 mm of the inked margin. Although in univariable and multivariable analysis, neither technique was found to be superior in reducing the incidence of a positive close margin ($P > 0.05$). However, this finding should be interpreted with caution, given the retrospective design, limited number of events, and potential for selection bias.

Table 3. Univariable and Multivariable Analysis of Factors Associated With Tumor Within 2 mm of the Resection Margin

		Univariable		Multivariable	
	Event/n	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	261/529	1.003 (0.99–1.02)	0.66	1.0009 (0.99–1.02)	0.91
LN status					
Negative	118/264	Ref		Ref	
Positive	70/150	1.08 (0.72–1.62)	0.70	1.12 (0.74–1.71)	0.59
Without LN sampling	73/114	2.20 (1.40–3.47)	<0.001	2.02 (1.21–3.38)	0.007
Type of operation					
Without cavity shave margins	179/367	Ref		Ref	
With cavity shave margins	82/162	1.08 (0.74–1.56)	0.70	1.13 (0.77–1.66)	0.54
Group					
IDC only	53/152	Ref		Ref	
DCIS only	72/125	2.54 (1.56–4.13)	<0.001	1.91 (1.08–3.36)	0.03
DCIS+IDC	136/252	2.19 (1.45–3.32)	<0.001	2.19 (1.44–3.33)	<0.001

CI, confidence interval; DCIS, ductal carcinoma in situ; Event/n, numbers of events (positive) and patients; IDC, invasive ductal carcinoma; LN, lymph node; OR, odds ratio.

Factors associated with the presence of tumor within 2 mm of the inked margin

In the multivariable analysis (Table 4), patients without LN metastases, those who underwent the CSM procedure, and those with only IDC had a lower risk of re-excision compared with those without LN sampling (OR, 4.21; 95% CI, 2.25–7.88; $P < 0.001$), those with LN metastases (OR, 1.93; 95% CI, 1.01–3.68; $P = 0.05$), those who did not undergo the CSM procedure (OR, 0.31; 95% CI, 0.16–0.59; $P < 0.001$), and those with only DCIS (OR, 3.10; 95% CI, 1.42–6.75; $P = 0.04$), respectively. In the CSM group, 1 patient with IDC, 6 patients with DCIS, and 7 patients with both IDC and DCIS underwent re-excision. In the non-CSM group, 13 patients with IDC, 37 patients with DCIS, and 28 patients with both invasive and in situ cancer underwent re-excision.

Table 4. Univariable and Multivariable Analysis of Factors Associated with Re-excision

		Univariable		Multivariable	
	Event/n	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	92/529	0.999 (0.98–1.02)	0.93	1.0008 (0.98–1.02)	0.94
LN status					
Negative	26/264	Ref		Ref	
Positive	22/150	1.57 (0.86–2.89)	0.14	1.93 (1.01–3.68)	0.05
Without LN sampling	44/114	5.75 (3.31–10.00)	<0.001	4.21 (2.25–7.88)	<0.001
Type of operation					
Without cavity shave margins	78/367	Ref		Ref	
With cavity shave margins	14/162	0.35 (0.19–0.64)	<0.001	0.31 (0.16–0.59)	<0.001
Group					
IDC only	14/152	Ref		Ref	
DCIS only	43/125	5.17 (2.67–10.02)	<0.001	3.10 (1.42–6.75)	0.004
DCIS+IDC	35/252	1.59 (0.83–3.06)	0.17	1.44 (0.73–2.81)	0.29

CI, confidence interval; DCIS, ductal carcinoma in situ; Event/n, numbers of events (re-excision) and patients; IDC, invasive ductal carcinoma; LN, lymph node; OR, odds ratio.

Association between surgical procedure and re-excision among patients with positive margin

Tumor on the inked margin

Among patients with a positive inked margin (Table 5), half (n = 10) of those in the CSM group required a second surgery, compared with 68.9% (n = 42) in the non-CSM group; however, this difference was not statistically significant ($P = 0.18$).

Table 5. The Association Between Cavity Shave Margins (CSM) and Re-excision Among Patients with Tumor-Positive Margins

	All (N=81)	Without cavity shave margins (n=61)	With cavity shave margins (n=20)	*P* value[a]
Re-excision, No. (%)				0.18
o	29 (35.8)	19 (31.1)	10 (50)	
Yes	52 (64.2)	42 (68.9)	10 (50)	

[a] Fisher exact test.

Tumor within 2 mm of the inked margin (positive close margin)

Among patients with positive close margins (tumor within 2 mm; Table 6), 15.9% (n = 13) of those in the CSM group required a second surgery, compared with 33% (n = 59) in the non-CSM group, which was a statistically significant difference ($P = 0.004$).

Table 6. The Association Between Re-excision and Cavity Shave Margin Among Patients with Positive Close Margins (Tumor Within 2 mm)

	All (N=261)	Without cavity shave margins (n=179)	With cavity shave margins (n=82)	*P* value[a]
Re-excision, No. (%)				0.004
No	189 (72.4)	120 (67)	69 (84.1)	
Yes	72 (27.6)	59 (33)	13 (15.9)	

[a] Fisher exact test.

In the subgroup analysis (Table S1, S2, S3), a significant association between the type of initial surgery and the likelihood of re-excision was observed only in patients with pure DCIS (Table S1), with 50% (n = 25) of the patients in the non-CSM group requiring a second surgery, while only 22.7% (n = 5) of the patients in the CSM group required a second surgery ($P = 0.04$). Among patients with only IDC (Table S2) or with mixed IDC and DCIS, the choice of initial surgery did not influence re-excision rates when close margins were positive (all $P > 0.05$).

DISCUSSION

This study aimed to evaluate whether excision of additional margins from the tumor bed at the time of primary surgery reduces the incidence of positive surgical margins (both inked margin and close margin) and the need for re-excision, compared with BCS without CSM across 3 groups: patients with only DCIS, patients with only IDC, and patients with mixed IDC and DCIS.

In our study, re-excision was left to the surgeon's discretion, which represents an important source of

potential bias that should be considered when interpreting our results. Our study failed to establish the superiority of the CSM technique over the standard surgical technique (without CSM) in reducing the incidence of positive margins (both inked margins and close margins). However, our study revealed that patients in the CSM group had lower rates of re-excision, particularly those with pure IDC. We also observed a strong association between re-excision and positive margins (both inked and close margins) in both surgical groups. Among patients in the CSM group (Table S1), re-excision was significantly more likely when a tumor was present on the inked margin (53.8% vs 6.6%) or within 2 mm of the inked margin (Table S2; 75.6% vs 41.5%; $P < 0.001$ for both). Similarly, in patients in the non-CSM group, re-excision was significantly more likely when a tumor was present on the inked margin (Table S3; 71.4% vs 6.8%) or within 2 mm of the inked margin (Table S4; 92.9% vs 46.6%; $P < 0.001$ and $P = 0.001$, respectively).

Many previously published studies[17-19] have consistently documented the beneficial effect of the CSM procedure in reducing the rate of positive margins compared with those without CSM. The heterogeneity in defining positive and close margins across previous studies may explain the nonsignificant effect of the CSM procedure in reducing positive margins observed in our results. These inconsistent definitions complicate direct comparisons. In our study, "CSM" was defined as the shaving of all 6 cavity margins. We applied stringent margin criteria for both invasive (IDC) and in situ (DCIS) components, ensuring a rigorous and systematic approach. In a randomized controlled trial, Chagpar *et al.*[17] reported a significant reduction in the incidence of positive margins from 34% to 19%. However, in this study, the authors defined close margins as those in which the tumor is present within 1 mm of the edge of the specimen.[17] In another study, Corsi *et al.*[20] compared standard BCS with BCS combined with the CSM procedure. They found that patients in the CSM group had significantly increased rates of cancers with negative margins (98.3% vs 74.4%) and decreased rates of re-excision (1.9% vs 18.9%). However, here the authors did not include close margins in their analysis.

The existing literature has also demonstrated a strong association between positive margins and tumor clinicopathological properties, such as tumor size (including both invasive and DCIS components)[21], presence of a DCIS component[22], DCIS size[23], and axillary LN status, on both univariable and multivariable analyses.[21] In 2023, Fauveau *et al.*[23] found that large-sized DCIS was independently associated with a higher rate of positive margins after standard BCS. Similar to the aforementioned studies, our study showed that patients with a larger DCIS size (Table S3) had a higher risk of having a tumor on the margin (OR, 1.18; 95% CI, 1.10–1.27; $P < 0.001$) and tumor within 2 mm of the margin (OR, 1.21; 95% CI, 1.12–1.32; $P < 0.001$) compared with those with a smaller DCIS size. In our study, patients with only IDC had a decreased risk of having a tumor on the margin compared with those with only DCIS, suggesting that the presence of a DCIS component is a high-risk factor for positive margins, regardless of the procedure used.

Our study revealed that patients in the CSM group had lower rates of re-excision, particularly those with pure IDC. The beneficial effect of the CSM procedure in decreasing re-excision rates observed in our study aligns with many previous studies[17–19], which reported that performing CSM with primary surgery results in a marked reduction in the need for a second surgery by more than 50%. Although only 50% of patients with a tumor on the inked margin in the CSM group required re-excision due to positive inked margins, compared with 68.9% (n = 42) in the non-CSM group, the difference was minimal ($P = 0.18$). However, we observed a statistically significant difference among patients with positive close margins in both groups, with patients in the CSM group having a lower risk of re-excision compared with those in the non-CSM group (15.9% vs 33%; $P = 0.004$), particularly in cases of only DCIS.

Our study has several limitations. First, the study focused on DCIS and IDC histological types of breast cancer and has not taken into consideration other common breast cancer types, such as lobular carcinoma in situ and invasive lobular carcinoma. Exclusion of in situ and invasive lobular cancer was based on the previously established data which established that pure lobular carcinoma is associated with increased margin positivity rates compared with IDC (8.63% vs 4.55%; $P < 0.001$)[7]; this limits the application of our findings to lobular carcinoma of the breast, which may have different clinical characteristics and outcomes. Second, variations in surgeons' practices in surgical technique selection and lack of standardized re-excision criteria might have introduced bias in the study. Third, we did not assess the effect of radiotherapy on the risk of re-excision in patients in either surgical group. Fourth, the retrospective nature of the study, missing data for a few cases, and lack of data on cost and resource utilization may have limited the analysis. Fifth, lack of information on prior surgical excisions and residual or recurrent disease, and the influence of preoperative tumor- or patient-related factors on the choice of surgical technique may introduce selection

bias. Sixth, a cohort from a single institution might introduce selection bias and reduce generalizability. Additionally, the study is limited by the lack of information on molecular profiles of the tumor and lymphovascular invasion, which are important prognostic factors in breast cancer. Finally, we did not consider the patient perspectives or report cosmetic outcomes comparing cavity shave margins without CSM.

CONCLUSION

BCS with the CSM procedure offers minimal benefit in reducing the incidence of positive margins compared with BCS alone in patients diagnosed with pure IDC, pure DCIS, and/or mixed invasive and in situ cancer. However, future large-scale studies with standardized margin guidelines and re-excision criteria, and assessment of tumor molecular profile and lymphovascular invasion are recommended to better guide clinical decision-making.

ETHICAL CONSIDERATIONS

This study was approved by the Wayne State University Institutional Review Board (Protocol #IRB-23-04-5738) and conducted in accordance with the Declaration of Helsinki, ensuring patient privacy and confidentiality. The Institutional Review Board waived the requirement for informed consent due to the retrospective design of the study and the use of deidentified data.

CONFLICT OF INTERESTS

The authors declare no conflicts of interest related to this study.

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DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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AI DISCLOSURE

The authors confirm that no generative artificial intelligence (AI) tools (e.g., ChatGPT, Bard, or similar systems) were used in the writing, editing, data analysis, or figure preparation of this manuscript. All content was generated and reviewed solely by the authors.

AUTHOR CONTRIBUTION

DJ: Conceptualization, Methodology, Investigation, Writing – Original Draft, Writing – Review & Editing. SB: Conceptualization, Writing – Review & Editing, Supervision. RAF: Conceptualization, Methodology, Writing – Original Draft, Writing – Review & Editing, Supervision. HJ: Formal Analysis. SK: Formal Analysis. SA: Investigation, Writing – Review & Editing, Supervision. MW: Investigation. ZK: Investigation. NES: Investigation. MAN: Investigation. FZ: Data Curation, Writing – Original Draft, Writing – Review & Editing

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